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激光与光电子学进展

基于二氧化钒的可调宽带太赫兹完美吸收器设计

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摘要 本文设计了一种可动态调节的宽频太赫兹完美吸收器，该吸收器由十字形的二氧化钒层、金属接地平面和夹在中间的二氧化硅层组成。仿真结果表明，90% 以上的吸收带宽为 1.06 THz，范围为 0.71～1.77 THz。吸收率随二氧化钒电导率的变化而变化，可在 4%～99.5% 之间动态调节。为了得到吸收器工作的物理机理，引入了阻抗匹配理论和波干涉理论，并通过电场分布分析了两个完美吸收峰的物理来源。该吸收器具有广角吸收和偏振不敏感的特点。该吸收器可以用于太赫兹传感器、探测器和隐身装备等。

关键词 材料；超材料；太赫兹吸收器；可调带宽；宽带

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Tunable Broadband Terahertz Perfect Absorber Design Based on Vanadium Dioxide

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Abstract A broadband terahertz (THz) perfect absorber that can be dynamically adjustable is designed. The absorber consists of a cross-shaped vanadium dioxide layer, metal ground plane, and sandwiched silicon dioxide layer. Simulation results indicate that a bandwidth of 1.06 THz (ranging from 0.71 to 1.77 THz) provides greater than 90% absorption. The absorptivity varies with VO_2 conductivity and can be dynamically adjusted from 4% to 99.5%. To obtain the physical mechanism of the absorber operation, impedance matching theory and wave-interference theory are introduced, and the physical source of the two perfect absorption peaks is analysed by electric field distribution. The absorber has the characteristics of wide-angle absorption and polarisation insensitivity and can be used in THz sensors, detectors, and stealth equipment.

Key words materials; metamaterial; terahertz absorber; tunable bandwidth; broadband

OCIS codes 160.3918; 300.1030; 050.6624

1 引 言

近些年，太赫兹技术在无线通信[1]、医学诊断[2]、成像[3]和生物传感器[4]等领域发展迅速。随着太赫兹技术的快速发展，出现了各种实用的功能器件，如滤波器[5-7]、吸收器[8-11]、偏振转换器[12-15]等。然而，自然界中能达到实用要求且能与太赫兹相互作用的材料非常少，极大地限制了太赫兹技术的发展。超材料的出现打破了这一限制，为太赫兹技术的发展开辟了新方向。在过去的十几年中，研究人员提出了各式各样的太赫兹超材料器件，其中的超材料完美吸收器（MPAs）在太赫兹传感器、探测器

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